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FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: C.3.2

United States of America

# TRANSFORMING IRRIGATION FROM AN AGE-OLD ART INTO A MODERN SCIENCE THROUGH RESEARCH AND TECHNOLOGY

By Robert M. HAGAN,
Chairman,
Department of Irrigation,
University of California,
Davis, California

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# TRANSFORMING IRRIGATION FROM AN AGE-OLD ART INTO A MODERN SCIENCE THROUGH RESEARCH AND TECHNOLOGY

by Robert M. Hagan
Chairman, Department of Irrigation
University of California, Davis, California

1. Economic and social development of many areas is dependent upon achieving increased agricultural production. This often requires the opening of additional lands to agriculture through new irrigation projects and also the improvement of existing irrigation systems to insure efficient water use and continued productivity of irrigated lands. A recent report 1/ of the Food and Agriculture Organization of the United Nations suggests that: "...improved water management (including irrigation and drainage practices) can probably do more towards increasing food supplies and agricultural income in the irrigated areas of the world than any other agricultural practice." Science and technology are now advanced enough, if properly integrated and summarized, to transform irrigation from an age-old art into a modern science capable of providing the basis for productive irrigation projects.

2. Irrigation was extensively practiced by the earliest civilizations known. Remnants of dams, canals and other structures testify to the extensive practice of the art of irrigation among the ancient peoples. Much of this irrigated agriculture ultimately failed because of technical problems created by incomplete planning and by misuse of watershed areas, soils and water. These problems include failing water supply, erosion and siltation of water storage and conveyance structures, excessive applications of irrigation water, leaching of soil nutrients, rising groundwater tables and waterlogging of soil, and ultimately accumulation of toxic salts. Unfortunately these same problems continue to cause the failure of some recently established irrigation projects, reduce crop yields far below potential productivity, and create economic and social unrest which so often accompany slowly developing and unproductive irrigation projects. In some areas food production lost through deterioration of irrigated lands is estimated to offset production from additional lands being brought into production under new irrigation schemes.

3. The development of water supplies may involve construction of impressive and ultra-modern engineering structures, but the developed water is often conveyed through inefficient distribution systems to farmers who continue to irrigate in accordance with age-old practices and traditions little influenced by modern science and technology. Actually, new or improved irrigation projects should not be considered as complete until scientifically sound and well-engineered provisions have been made to apply water efficiently to the last crop row on the last farm and adequate arrangements made to remove any surplus water wherever necessary. Intelligent application of today's knowledge of irrigation science and technology would accelerate the effective utilization of water and soil resources in developing areas, achieve maximum crop production from available water supplies, insure an abundant and permanently successful irrigation agriculture, and reclaim many previously productive lands now waterlogged and often salinized.

1/ Houston, C. E., Recommendations for Improved Water Management Programs, Food and Agriculture Organization, Rome, unnumbered mimeo. (1962).

4. The modern science of irrigation, in a broad sense, must seek to increase the efficiency of converting rain or other precipitation into useable water and to reduce all losses in utilizing this water. FIGURES I and II illustrate some of the elements in the water-supply and water-utilization systems and some of the sources of water loss. Each loss represents a challenge to the irrigation scientist and engineer to seek economic means for its reduction or elimination.

5. Since modern science and technology are now generally employed in construction of water supply projects, this paper will concentrate on opportunities to use present knowledge for increasing the effectiveness of man's utilization of developed water supplies. This requires the skillful combination of accumulated knowledge in many professional fields including engineering, soil science, plant science, and agricultural economics. Difficulties in obtaining and coordinating the knowledge from the many professional disciplines involved contribute to serious problems encountered in planning and operating many irrigation schemes.

6. Irrigation needs and practices vary widely. This complicates the planning of new irrigation projects and also the operation of existing irrigation systems and irrigated farms. One important aspect of science is the ability to predict what results can be expected in given situations. Mankind in general, and particularly the less developed countries, can ill-afford the time-wasting, resource-depleting, and disappointing process of trial-and-error and inadequately planned local trials. With the gradual development of modern irrigation science, basic irrigation principles are emerging which can serve as valuable guides in predicting irrigation requirements and potential problems. Now available in both the developed and developing countries are much knowledge and methodology for evaluating irrigation sites, determining the suitability of proposed irrigation waters, estimating irrigation requirements of crops, predicting the effects of specific irrigation practices and related farm operations on given crops under prevailing site conditions, diagnosing drainage needs, and estimating leaching requirements to maintain favorable salt balances. Considerable information is also available on the tremendously important interrelations between irrigation, fertilization, tillage, and other crop production practices.

7. The success of any agriculture, especially an irrigated agriculture, is dependent upon the soil. Modern methods of soil survey and land classification provide an essential inventory and summary of soil characteristics. Soil investigations should include textural and structural conditions of soil profile, infiltration and and hydraulic conductivity, water retention characteristics, nutrient status, salinity, etc. Such modern instrumentation as pressure plate and pressure membrane apparatus, flame photometers, pH-meters, and electrical conductivity meters are available to aid in quickly appraising soil properties. Although there is a great need for further development of such measurements, present knowledge and instrumentation permit reasonably accurate prediction of soil behavior under irrigation and should avoid the economic and social tragedies arising from developing and settling people on lands unsuited to irrigation farms.

8. Investigations of water supplies to be used for irrigation should include considerations of both quantity and quality (content of dissolved or suspended materials). Research by the U.S. Salinity Laboratory 2/ and other agencies provide valuable guidance in predicting the effects of given waters on soil properties and ultimately on crop production. Methods and instruments developed by the Salinity Laboratory are now used in many countries for water analysis and prediction of irrigation suitability. However, for accurate prediction, information on climatic conditions of the area (evaporation and rainfall), soil properties (including clay minerals), irrigation method, drainage conditions, and crops to be grown must also

2/ Richards, L. A. (editor), Diagnosis and Improvement of Saline and Alkali Soils, U. S. Department of Agriculture, Agric. Handbook No. 60. (1954).

be considered in addition to water analysis data. Water quality considerations will become increasingly important as more complete utilization is made of available water supplies.

9. Vital for planning, operations, and the ultimate success of an irrigation project is reliable information on consumptive use of water by different crops as well as the seasonal and annual variations in these requirements. Such data provide the basis for selection, construction, and operation of storage structures, conveyance and distribution networks, and irrigation systems. Consumptive use should also be a major factor in selecting crops to be grown in water-deficient areas. It has become a highly important factor in arbitration of controversies over river systems both within and between nations.

10. Consumptive use is difficult to measure directly. Research in the United States and Europe has developed methods for utilizing climatic data for estimating consumptive use. Formulae proposed by Penman, Thornthwaite, Turc. Lowry-Johnson, and Blaney-Criddle are widely used and, unfortunately, sometimes misused. The simpler, but more empirical formulae, are satisfactory only if the local correction factors, which are substantial, are known. The extensive investigations correlating water evaporation from standard pans with consumptive use may be useful, but they also require knowledge of required correction factors. Although much more research is needed, present knowledge intelligently applied could provide the basis for wise selection of crops and more efficient planning and operation of irrigation projects and systems.

11. The gross effects of deficient and of excessive soil water on plant growth are well known, but there has been much controversy about specific irrigation practices required to produce a desired level of crop production. Some irrigation specialists have advocated relatively infrequent irrigation, while others have favored keeping the soil quite wet. Many agriculturalists, knowing that water is essential for crop growth, assume that the more irrigation water applied, the higher the crop yield obtained. This belief leads many farmers to irrigate with unnecessary frequency and with a great waste of water--thus leaching plant nutrients and aggravating drainage problems.

12. Since water, especially in the arid regions, is a limiting and usually a costly resource, it is generally desirable to plan irrigation programs for "efficiency" in terms of maximizing crop yield per unit of water applied. In some cases it may be preferable to maximize crop yield per unit of irrigated land or per unit of initial investment in land preparation or irrigation distribution system. Thus the most desirable irrigation practice will vary with the situation and depend upon proper integration of all factors involved. Efforts 3/, 4/ are now being made to formulate some general irrigation principles useful in determining irrigation practices. The practices to be recommended should be based on sound irrigation principles and should be designed specifically in accordance with prevailing soil, crop, climate, management and economic factors. Irrigation practices should not be merely copied from irrigation practices reported as successful elsewhere without carefully comparing all factors involved. It should be emphasized that a permanently successful irrigation agriculture requires that the irrigation, fertilization and other cultural practices be carefully tailored to match local conditions.

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3/ Israelsen, O. W. and Hansen, V. E., Irrigation Principles and Practices, John Wiley and Sons, New York-London. (1962).

4/ Hagan, R. M. and Vaadia, Y., Principles of Irrigated Cropping, UNESCO Arid Zone Research Proceedings, Plant-Water Relations Symposium, pp. 215-225, Madrid. (1959).

13. Detailed research on the effects of irrigation on the physiology of the cotton plant (carried out at the Cotton Research Station at Shafter, California by scientists of the U.S. Department of Agriculture and the University of California) may help answer some baffling problems encountered with irrigated cotton in developed and developing countries. For example, recent investigations 5/ made by a scientist from California, while serving as an expert with FAO, suggest that much of the severe loss of cotton production experienced in the United Arab Republic (Egypt) in 1961, which gravely affected the financial position of that country, was likely caused by irrigation practices which, although traditional, were not favorable to the cotton plant under the climatic conditions of this year. He believes adverse irrigation practices and resultant unfavorable drainage were more responsible for the crop loss than the so-called "reddening" disease or insect infestations. It is estimated that application of recent research on cotton irrigation could increase U.A.R.'s cotton yield nearly 50% or about 250 million dollars per year at today's prices while at the same time permitting substantial savings in irrigation water and reducing drainage requirements.

14. Research on crop irrigation reveals many opportunities to influence the development of crop plants so as to best serve man's needs. Studies in the United States showing possibilities for increasing the percentage of sugar in maturing sugar beets by withholding irrigation are now being successfully applied in Israel with important savings of water in this arid country. Research demonstrating the critical periods in the water relations of maize, when combined with better varieties and improved cultural practices, now permits this grain to augment the food resources of Central and South America, Africa and India.

15. To take full advantage of available research on irrigation of crops, water must be conveyed to the farmers' fields and spread in accordance with the water requirements of the crop and soil characteristics. Many countries are tolerating appalling wastes of water in conveyance, distribution, and application losses. Leached soils, high groundwater tables, and salinity are the unfortunate consequences of such losses. The poorly controlled application of irrigation water shown in FIGURE III is unfortunately still a common sight in both developed and less-developed countries. Contrast FIGURE III with the neatly graded contour furrows of FIGURE IV which permit much more efficient irrigation with less labor.

16. The irrigation method to be used should be carefully selected in accordance with topography, soil, rate of water delivery, drainage hazards, the crop and its consumptive use, water quality, salinity, and other considerations. If conditions favor use of sprinkler systems, they must be designed correctly and used under the conditions for which they were designed. If conditions favor surface irrigation --either border, furrow, corrugations, basins, or controlled flooding--the land must be topographically surveyed, graded, and the correctly computed size of head ditch or pipeline determined. The proper length of run, width of border, or size of basin must be selected, but this is most difficult. Because of variability in rates of water intake into soils and other factors, the irrigation engineer must still depend partially on local experience and trial-and-error methods. However, the engineer's art is now being supplemented by scientific research which is providing methods for more accurate prediction of irrigation system performance. Considerable information is available on land grading and on selecting, designing, and operating different irrigation systems in publications issued by the U.S. Department of Agriculture and University Agricultural Experiment Stations. A pamphlet on grading land for surface irrigation 6/ prepared in California has now been reprinted by other countries in

5/ Walhood, B. T., Report to Government of U.A.R. on Physiologic Problems in Cotton, FAO, Division of Plant Production, Mimeo., (in press).

6/ Marr, J. C., Grading Land for Surface Irrigation, University of California Agricultural Experiment Station and Extension Service, Circular 438 (1957).

French, Greek and Spanish and is extensively used by developing countries.

17. Very efficient, but expensive, machines are now available to grade land for irrigation. In many cases these large and costly machines are not suitable for use in developing countries. The activities of an U.S.A.I.D. irrigation specialist working in India, Mr. George C. Knierim, demonstrate the successful application of sound principles of irrigation system design simplified to meet local conditions and carried out using very simple and inexpensive land grading tools made by a village blacksmith or the farmer himself from local materials. Buck scrapers, ridgers, corrugators, furrowers, and cultivators have been built by adapting tools used by the Mormon and other pioneers in the American West. It is estimated that some 60% of all water supplied for irrigation in India is lost. Water lost on improperly prepared fields constitutes a major loss. As shown in FIGURE IV, Mr. Knierim and his Indian associates are now able to grade fields for efficient irrigation and drainage, even on difficult soils and terrain, thus boosting the productivity of the land often by as much as four- or six-fold. With improved water management, salinity hazards are greatly reduced. His advice: sound principles, simple methods, and simple tools. This work illustrates that the conversion of irrigation from art into a science need not be dependent upon costly imported equipment.

18. Modern technology now produces an array of materials and equipment to control seepage, possibly reduce evaporation, and regulate flow in canals, distributaries, and on fields. Although some materials and equipment are relatively expensive, their use by less developed countries to conserve water, stimulate crop production, and avoid water-logging should be seriously considered. Some water control equipment can be produced inexpensively from local materials. FIGURE V shows an inexpensive and locally made canvas dam being used in India to hold water in irrigation ditches, and FIGURE VI shows simple spiles employed in Jordan to control effectively the flow of water from a forebay into furrows. Very satisfactory spiles can be easily cut from bamboo in many tropical countries.

19. Siphons are now often used to deliver water from a supply ditch over its bank and onto the land. They permit easy control of water, eliminate cutting ditch banks, greatly facilitate ditch maintenance, and provide much more accurate control of quantities of water being applied. They can be easily constructed out of metal, plastic or rubber. Flow tables for different siphon sizes and operating heads are readily available and have been reproduced in many countries.

20. An age-old practice in Egypt, improved by modern scientific analysis at the U.S. Salinity Laboratory 7/, now provides a clever means of reducing salt damage to germinating seedlings. By special shaping of seedbeds and furrows causing salt to accumulate away from seed rows, salt concentration around germinating seeds may be greatly reduced, permitting emergence of a good stand even in the presence of saline soils and irrigation waters.

21. No irrigation project should be conceived or operated without attention to possible drainage requirements. Although the art of drainage is probably as old as agriculture itself, the need for drainage is still frequently overlooked. Painstaking research by mathematicians, soil physicists, and engineers has produced in the last 20 years effective means for analyzing the causes of drainage problems, predicting required capacities, and selecting the optimum depth and spacing of drains. Soil chemists have developed guides for computing the amount of water which should pass through soils to leach salts and maintain favorable salt balances. Thus engineers now have a valuable body of scientific knowledge to guide them in drainage system design and operations.

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7/ Bernstein, L., Fireman, M., and Reeves, R. C., Control of salinity in the Imperial Valley, California, U.S. Dept. of Agriculture, ARS-41-4 (1955).

22. The irrigated plains of the Indus River and its tributaries in West Pakistan constitute one of the most difficult irrigation and drainage problem areas of the world. Today, waterlogging and salinity are causing approximately 100,000 acres to go out of agricultural production each year. Additional large areas are partially affected by inadequate drainage and salts which have together reduced crops yields to levels of only 30 to 50% of those in comparable well-drained non-saline soils.

23. The attack now being made on this enormous problem by a special United States team of scientists and engineers[8/], working under agreements with the Republic of Pakistan, provide a striking example of the application of modern science and technology to the solution of complex and vast irrigation and drainage problems. This team is employing mathematical model techniques and high-speed digital computers to study the feasibility of using tubewells to drain the Indus area and provide a water management program which will permit restoration of a productive agriculture. More specifically, they seek: (1) to evaluate choices between water management designs involving different combinations of tubewells, surface drains, subsurface drains, and canal lining with sealants; (2) to determine the optimal number, spacing and depth of tubewells for irrigation project areas, and to identify the optimal schedule of pumping water for crops or to drains during the year to maximize agricultural productivity and to control the salinity of the irrigation water: and (3) to study the mechanism of the salt balance including leaching from root zones, movement of salts in the ground water, interactions between adjacent regions arising from discharge of brine to the waterways, and the magnitude of the salt accumulation in aquifers during the next 50 years. Another general objective is to test and demonstrate the use of modern techniques of systems analysis and electronic computers for economic and engineering analysis, as a basis for planning and design of irrigation and drainage systems.

24. Many irrigation specialists who have studied the problems of the Indus Plain over the past 20 years assumed that the waterlogging and salinity problems were caused by canal seepage and over-irrigation. Accordingly, most specialists have suggested lining canals and reducing excessive irrigation. By using a fresh scientific approach to an old and difficult problem, new solutions have been proposed. In brief, these new techniques indicate for this area that: (1) tubewell systems can effectively eliminate waterlogging and salinity in large areas of West Pakistan although several test well projects during the past 15 years have not been encouraging; (2) tubewells can provide an important supplemental water supply for increasing agricultural production on the Indus Plain; and (3) the lining of canals to retard seepage cannot be justified under present costs in this area. The computer also provides data on optimal spacing and depth of wells and on pumping programs for wells to maintain salinity within tolerable limits.

25. As illustrated by this Pakistan study, mathematical models, digital computers, and other techniques under development can give the irrigation scientist and engineer powerful new tools to hasten the progress of irrigation from an art into a fully modern science. These new techniques permit rapid and accurate consideration of a vast spread of hydro-agronomic conditions and of technological possibilities in order to formulate corresponding responses corrected, as necessary, for "feed-back" relations. These techniques are not merely problem-solving tools; they are perhaps even more useful as problem-identification tools. By synthesizing the best available data in a theoretical construct, even though

8/ Information on West Pakistan project from preliminary statement by Professor Harold A. Thomas, Jr. for later inclusion in Draft Report of White House-Interior Panel on Waterlogging and Salinity of West Pakistan. For more complete discussion of these techniques, see Maass, A. et al, Design of Water Resource Systems, Harvard University Press, Cambridge, Massachusetts. (1962).

incomplete, it is possible with error analysis to show quantitatively the effect upon practical conclusions of the inadequacy of certain planning data and also the cost of having to base decisions on poor rather than good data. With the multiplicity of variables and inter-actions involved in irrigation and drainage projects, the simulated results yield a rational basis for evaluating the relative importance of variables and of types of data obtainable from field and laboratory observations. This permits problem-identification. It also provides the irrigation specialist with valuable guidance for selecting data to be collected as the basis for planning, operations, and long range predictions. Such techniques add much to the modern science of irrigation.

26. Man has within his grasp the means to insure a highly productive and permanently successful agriculture, if full advantage is taken of opportunities now available to transform the art of irrigation into a modern science. Useful aids in doing this are Monographs on Irrigation[9] (in preparation), Drainage[10], and Salinity[11] which summarize research in these subject areas. An FAO-UNESCO Sourcebook[12] is also being written. These detailed Monographs and the more general Sourcebook should provide irrigation scientists and engineers with valuable guidance. Man's goals of more favorable living standards in this increasingly populous world can be met much more quickly both by increased utilization of the world's science and technology and by more effective cooperation between engineers, soil and crop scientists, and other professional groups whose combined efforts are needed to attain an abundant and permanently successful irrigation agriculture.

9/ Hagan, R.M., Haise, H.R., and Edminster, T.W. (editors), Irrigation of Agricultural Lands, American Society of Agronomy Monographs Series, (in preparation).

10/ Luthin, J. N. (editor), Drainage of Agricultural Lands, American Society of Agronomy Monographs, Vol. VII, Madison, Wisconsin (1957).

11/ Richards, L.A. (editor), Diagnosis and Improvement of Saline and Alkali Soils, U. S. Department of Agriculture, Agric. Handbook No. 60 (1954). Note: a revised edition is in preparation.

12/ Kovda, V., Hagan, R. M., and van den Berg, C. (editors), FAO-UNESCO International Sourcebook on Irrigation and Drainage of Arid Lands in Relation to Salinity and Alkali, (in preparation; to be published by FAO and UNESCO).

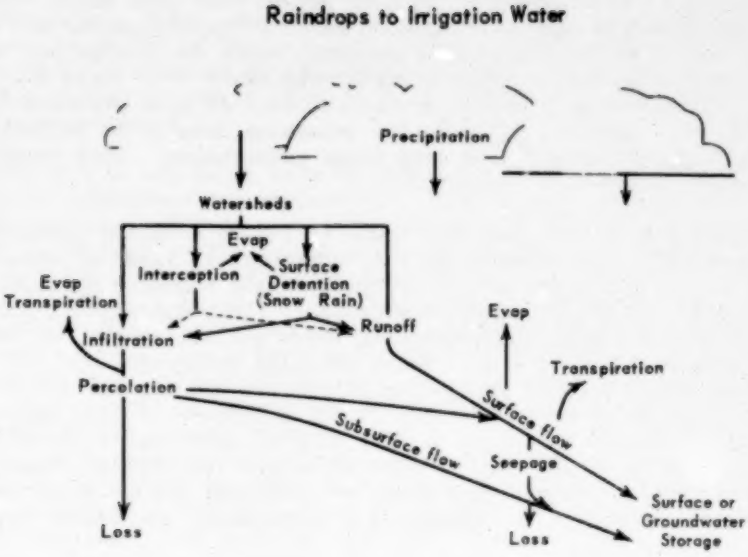


Fig. I Sources of Losses in converting precipitation to irrigation water.

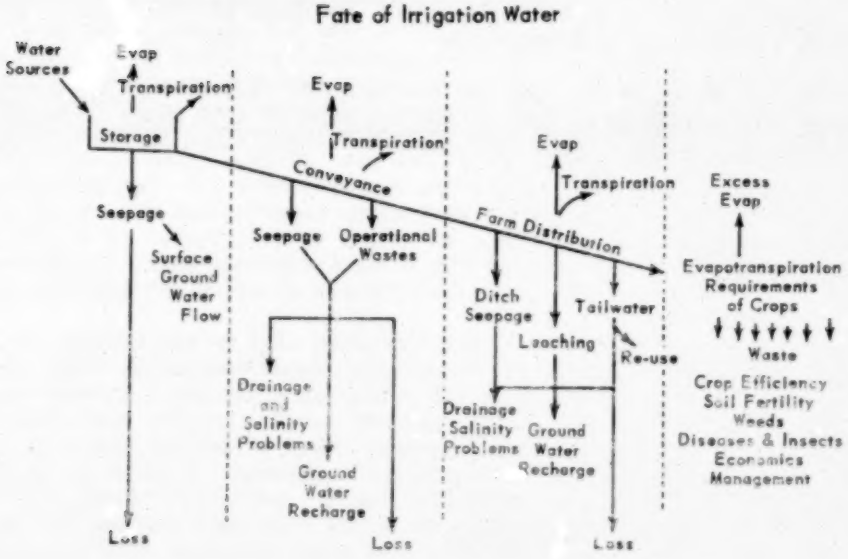


Fig. II Water losses in storage, conveyance, distribution and crop growth

Fig. III -

Inadequately prepared field makes efficient irrigation difficult

Fig. IV -

Graded contour furrows for efficient irrigation and drainage (India)

Fig. V -

Inexpensive canvas to control water in ditches (India)

Fig. VI -

Head-ditch, forebay, and spiles for control of water to furrows (Jordan)

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**SUMMARY**

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1. Irrigation was extensively practiced by earliest civilizations known to man. Much of this irrigated agriculture failed because of misuse of water led to erosion and siltation, excessive leaching of soil nutrients, waterlogging, and ultimately salinity. Today the same conditions limit crop yields in extensive areas and even have caused failrue of recent irrigation projects. In some regions, food production lost through deterioration of irrigated lands may offset production from new lands brought into production under irrigation.

2. Even where development of water supplies involves construction of ultra-modern engineering structures, developed water is often conveyed through inefficient distribution systems little influenced by science and technology to farmers who continue to irrigate according to age-old practices and traditions. The modern science of irrigation, in a broad sense, seeks to increase efficiency in converting precipitation into useable water and to reduce losses in utilizing this water. Each loss represents a challenge to the irrigation scientist and engineer to find economic means for its reduction or elimination. Intelligent application of today's knowledge of irrigation science and technology can accelerate irrigation project development, achieve maximum crop production from available water, reclaim previously productive lands now waterlogged and salinized, and insure an abundant and permanently successful irrigation agriculture.

3. One important aspect of science is the ability to predict expected results in given situations. Man cannot afford time-wasting, resource-depleting, and trial-and-error approaches in irrigation. Much knowledge and methodology is now available for evaluating irrigation sites, determining suitability of irrigation waters, estimating crop irrigation requirements, predicting effects of specific irrigation practices, diagnosing drainage needs, and estimating leaching requirements to maintain favorable salt balances.

4. Irrigation practices recommended should be based on sound irrigation principles and designed specifically in accordance with prevailing soil, crop, climate, management, and economic factors. Research on crop irrigation reveals many opportunities to increase irrigation efficiencies, improve crop yields, and influence the development of plants to best serve man's needs. Cited is a severe decline in cotton production which appears to have been caused largely by traditional but inadequate irrigation practices.

5. To take full advantage of research on crop irrigation, water must be conveyed to farmers' fields and spread in accordance with crop water requirements and soil characteristics. Many countries are tolerating appalling wastes of irrigation water. The irrigation method to be used should be selected in accordance with

topography, soil, rate of water delivery, drainage hazards, crop and its consumptive use, water quality, salinity, and other considerations. The irrigation engineer must still depend partially on local experience and trial-and-error methods, but the engineer's art can now be supplemented by research which provides methods for more accurate prediction of irrigation system performance.

6. Efficient but expensive machines available to grade land for irrigation are often not suitable for developing countries. The activities of a specialist working in India illustrate opportunities to build inexpensive land grading and cultivation devices from local materials which, when used in accordance with modern technology, can greatly improve irrigation practices and crop yields on difficult soils and terrain. Examples of water control equipment produced inexpensively from local materials are given. Special shaping of beds and furrows to minimize salt damage on seedlings under irrigation is reviewed as an example of a successful combination of an age-old practice from Egypt with improvements introduced by scientific analysis.

7. Research by engineers, soil physicists, and soil chemists has now produced effective means for analyzing causes of drainage problems, predicting required capacities, selecting optimum depth and spacing of drains, and computing amounts of leaching water to maintain favorable salt balances.

8. A study of waterlogging and salinity problems of the Indus River Plain provides a striking example of modern science and technology applied to solutions of complex irrigation and drainage problems. By using mathematical models and high-speed digital computers, new solutions to this old problem are proposed. These new techniques permit rapid consideration of many hydro-agronomic conditions and technical possibilities. These techniques are not merely problem-solving tools; they are even more useful for problem-identification. They provide irrigation specialists with valuable guidance in selecting data for planning, operations, and long-range predictions.

9. Man has within his grasp the means to insure a highly productive and permanently successful agriculture if full advantage is taken of opportunities now available to transform the art of irrigation into a modern science. Useful aids are monographs on irrigation, drainage, and salinity, and also an FAO-UNESCO sourcebook in preparation. Goals of better living standards in an increasingly populous world can be met more quickly by increased cooperation between irrigation engineers, soil-crop scientists, and other professional groups whose combined efforts are needed to attain a permanently successful irrigation agriculture.



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United States of America

# MEETING HUMAN NEEDS THROUGH AGRICULTURAL AND FOOD PRACTICES

By Nevin S. SCRIMSHAW,
Head of Department of Nutrition,
Food Science and Technology,
Massachusetts Institute of Technology,
Cambridge, Massachusetts

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# MEETING HUMAN NEEDS THROUGH AGRICULTURAL AND FOOD PRACTICES

Nevin S. Scrimshaw
Head of Department of Nutrition, Food Science and Technology
Massachusetts Institute of Technology
Cambridge, Massachusetts

## Introduction

1. The application of available scientific and technical knowledge to agricultural and food practices in the less developed regions of the world is urgently needed. It is increasingly recognized that the excessive mortality in such areas, particularly among young children, is due in considerable degree to the effect of malnutrition in lowering their resistance to infection and in many cases death results from malnutrition itself.1/ Evidence has also been obtained that subsequent intellectual performance is retarded by the malnutrition which in most technically underdeveloped areas interferes with the growth and development of preschool children.2/ Furthermore, if people are to have the strength and will to work well in agriculture and industry they must receive adequate nourishment.

2. The improvement of human nutrition on a national scale will usually require greater production and more efficient conservation of food as well as better dietary habits. In most of the highly developed countries the production and conservation of food have improved steadily despite sharp reductions in the land area under cultivation and far fewer people employed directly in agricultural production.

3. For any area there is usually considerable technological information available for direct application, but the suitability of all recommendations must be evaluated in relation to local conditions and, where necessary, modifications made before their use. Many mistakes are made by persons trained outside the region who assume, without actually testing a proposed change, that what works in one area will also be useful in another. On the other hand, adequately trained persons are able to adapt experience in one area to local conditions in a different one.

4. Even when this is done, however, there remain agricultural and food problems in all areas, and particularly in the less developed ones, which require further research and not just adaptation of results obtained elsewhere. Thus a program for improving agricultural production and food use which does not include needed research is incomplete and seriously handicapped.

5. Application of knowledge of better agricultural and food practices is often thought of as requiring only educating or persuading the people who produce, handle, and consume food. This is exceedingly important but so is the dissemination of knowledge among the top levels of administrative and policy-making officials of both governmental and non-governmental organizations. When persons

1/ Scrimshaw, N. S., and Behar, M., Protein malnutrition in young children, Science, 133, 2039-2047 (1961).

2/ Cravioto, J., Robles, B., and Ramos-Galvan, R., Influencia del estado de nutricion sobre el desarrollo del nino en el medio rural de Mexico. Bol. Med. Hosp. Inf. Mex., in press (1962).

in posts of authority are not sufficiently well informed, needed legislation is postponed or defeated; funds are not made available for vital functions; training, research and extension programs are not supported; and policy mistakes are needlessly made. It is only when scientific and technological knowledge is appropriately disseminated throughout a population that its full potential can be achieved.

## Improving Food Conservation

6. The factors responsible for the much higher crop yields per unit of comparable land in the United States and other highly developed countries are discussed in other papers. The increases in food production in these countries have tended to obscure the significance of the remarkable improvements which they have also made in the conservation of food. For centuries mankind was dependent for food preservation on a limited number of processes, mainly smoking, drying, salting and to a limited extent the refrigeration offered by caves, wells, cold weather and natural ice. With the development of heat-resistant, hermetically-sealed containers in the 19th Century thermal processing came into widespread use.

7. In the 20th Century mechanical production of ice and later the development of mechanical refrigeration led to the widespread use of cold for the conservation of food during storage and distribution. After very small beginnings before the Second World War, freezing has now come to be a major means of conserving food in the United States, and the most rapidly expanding branch of the food industry during the last decade.

8. Both refrigeration and freezing depend on the widespread availability of mechanical units, but a relatively recent development, the combination of freezing and vacuum drying, results in a product which retains the flavor and physical properties of fresh food when rehydrated. In dry form, it can be stored indefinitely without refrigeration. Although relatively costly, this process has many advantages for food handling in tropical areas, and less expensive vacuum drying without freezing can be applied to certain types of food products without a marked change in their flavor and texture.

9. Also of potential significance to underdeveloped areas is the use of ionizing radiation to extend the life of foods although the early hope of using sterilizing doses of radiation seems impractical because of the resulting nutritional and flavor damage. Experiments are continuing with lower dosages of radiation which have a pasteurizing effect. Antibiotic dips are also being used to extend the shelf life of some products. Other useful chemicals include mold inhibitors, such as the propionates in bread; antioxidants, which delay development of one kind of fat rancidity; emulsifiers, such as the ones used to prevent separation of mayonnaise; bleaching agents, as for flour; thickening agents; and substances to prevent caking of powders.

10. Conservation of food begins with the use of chemicals in the field to prevent losses due to insects, to fungal and viral plant pathogens and even to the premature dropping of fruit. It requires adequate storage facilities to protect food from rodents and insects and may involve the control of temperature and humidity or the application of pesticides or other chemicals. Food conservation measures extend to better ways of packing, shipping and distributing food to the consumer. The extensive use of polyethylene and other synthetic films for everything from reducing the damage to stalks of bananas during shipment to the prepackaging of market vegetables, fruits and even meats has helped greatly to reduce waste. The more rapid transportation of foods by fast refrigerated ships, trains and trucks, and by airplane have all reduced the loss of food between producer and ultimate consumer in the developed countries.

## Food Enrichment

11. An important means of extending food supplies or making them more effective in human nutrition is enrichment with one or more essential nutrients.

The addition of potassium iodide to salt initiated in the 1920's in Switzerland and the United States contributed greatly to the elimination of goiter as a public health problem in these countries. Potassium iodate has the advantage of being stable even when added to crude moist salt. It has recently been used for salt iodization on a national scale in a number of technically underdeveloped countries and has brought about striking reductions in the prevalence and severity of endemic goiter. In Guatemala over 90 per cent of the population lived in areas with from 30 to 60 per cent goiter before iodization of salt in that country. In August 1962, approximately two years after the initiation of this preventive measure, the prevalence was found to have dropped to less than 10 per cent in most areas and a maximum of 15 per cent in several border populations with access to some non-iodized contraband salt. Similar results were earlier obtained in the department of Caldas, Columbia as well as in Ohio and Michigan in the United States.

12. The enrichment of wheat flour with thiamine, riboflavin, niacin and iron became widespread in the United States two decades ago and later in Canada; it is one of several factors contributing to the almost complete disappearance of acute vitamin deficiences in North America. The enrichment of refined wheat flour is now required by law in a number of other countries including all of those in Central America. It should be adopted by all countries presently using large quantities of refined wheat flour and by those in which whole grain cereals are gradually being replaced by white flour with its lower vitamin and mineral content.

13. Enrichment of polished rice with a similar combination of vitamins was demonstrated to be an effective means of preventing beriberi in a rice-eating population through mass feeding trials carried out in Bataan, the Philippine Islands, during the years 1948-1950. Most polished rice sold in the U.S. is now enriched and this is required by law in Puerto Rico. Enrichment of wheat flour and rice with all three B-complex vitamins and with calcium and iron costs only a few cents per person per year and is strongly recommended by international health authorities. Much of the corn flour or meal sold in the United States is enriched in the same way. Field trials conducted in Yugoslavia have demonstrated that the procedure will eliminate pellagra in a population suffering from this deficiency as a result of diets consisting mainly of maize.

14. Attention is now being given to the practical aspects of improving protein quantity and quality by economical enrichment procedures. The amino acid, methionine, in synthetic form is already extensively added to animal feeds in the United States to increase their protein efficiency, and the addition of lysine to wheat flour or bread has been demonstrated to raise the proportion of utilizable protein from one-half to nearly two-thirds. When threonine becomes available at low cost the net protein utilization can be raised further to nearly the values for meat and milk protein. A marked improvement in the nutritive value of corn flour can also be accomplished by using 3 per cent fish flour, 3 per cent egg powder, 3 per cent food yeast, 5 per cent skim milk, 8 per cent soya flour or 8 per cent cottonseed flour.3/

15. Such supplements are not only cheaper than synthetic amino acids, but they also have the advantage of improving the total quantity of protein as well as the efficiency of utilization of the protein already present. As progress in synthesizing essential amino acids continues and prices decrease, it should become practical to use synthetic amino acids to improve the quality of the protein in many foods whose protein value is now limited by amino acid deficiencies and imbalances. Such a practice will greatly extend the usefulness of foods of vegetable origin whose protein is partially wasted by the body.

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3/ Bressani, R., Marenco, E., and Valiente, A. T., Enrichment of lime-treated corn flour with animal and vegetable proteins and with amino acids, Abstr. Fifth Int. Cong. on Nutrition, Sept. 1-7, 1960, Washington, D.C., p. 59.

## Better Yielding and More Nutritious Varieties

16. Great progress has been made in developing higher yielding and more resistant varieties of plants and this is one of the major reasons for the increases in agricultural production in the developed countries. Part of the increase in corn yields in the U.S. and other developed countries is due to the use of hybrid seed, and the higher-yielding varieties of wheat, oats, soya and other basic crops available. Other examples are wilt-resistant peas and cabbages, mosaic-resistant snap beans, virus-resistant potatoes, mildew-resistant cucumbers and lima beans, anthracnose-resistant watermelons, and strawberries resistant to leaf spot and red stele.

17. Progress has also been made in selecting varieties of plants for desirable nutritional characteristics; much more will be possible when serious attention is paid to nutritive value. Cereal grains with higher protein quantity and quality, cottonseed with no gossypol pigment to bind the available lysine during pressing and squash with a high carotene content are among the examples.

18. New breeds of animals have also contributed to the yield per unit of feed and nutritive value of foods of animal origin. Hens have been selected for maximum egg production per unit of feed, dairy cattle for efficiency of meat and milk production and swine for rate of growth and growth per unit of feed. Hogs with more lean meat and less fat, poultry bred and fed for maximum lean meat per unit of total weight, and dairy cattle selected for high butterfat content of milk have been in regular commercial production in the U.S. for many years.

## New Food Products

19. As the growing population exerts more pressure on the food supplies of most countries, the search for economical and nutritious new sources of food is intensified. Of greatest promise for most tropical countries are combinations of the oilseed meals and cereal grains.[4] The press cakes from soya, cotton, sesame, sunflower, and peanut contain approximately 50 per cent protein and are relatively low priced because part of the cost of production is met by selling the oil. When combined with about two-thirds of a cereal grain, the oilseed meals give a dry food containing about 25 per cent protein of a quality approaching that of proteins of animal origin.

20. The addition of a small amount of yeast and either a leaf meal or synthetic vitamin A gives a highly nutritious basic food. This is the principle used in the development of low cost vegetable mixtures by the Institute of Central America and Panama. Some of these are already being manufactured under the generic name Incaparina and are sold as new basic foods in eight Latin American countries.

21. This food which contains 38 per cent cottonseed flour, 3 per cent torula yeast, either 3 per cent leaf meal or synthetic vitamin A, 1 per cent calcium carbonate and the remainder corn, sorghum, rice, wheat or other cereal is effective in the treatment of severe protein malnutrition in children and produces a nitrogen retention similar to that of milk in young children fed at a level of 2 to 3 gm. of protein per kg. per day.[5] Almost any region has either the raw materials for such a mixture or the potentiality of growing them.

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4/ Scrimshaw, N. S., and Bressani, R., Vegetable protein mixtures for human consumption, Fed. Proc., 20 (Supple. No. 7), 80-88 (1961).

5/ Scrimshaw, N. S., Behar, M., Wilson, D., Viteri, F., Arroyave, G., and Bressani, R., All-vegetable protein mixtures for human feeding. V. Clinical trials with INCAP mixtures 8 and 9 and with corn and beans, Am. J. Clin. Nutrition, 9, 196-205 (1961).

22. Much interest has been expressed in the possibility of using isolated protein from cereal, legumes or oil seeds for human feeding but they seem likely to remain too expensive to be of practical importance in the near future. In areas with abundant coconuts, the protein of copra can be advantageously used in foods for human consumption. Food yeast has value as a supplementary source of B-complex vitamins and also contributes useful protein. Unfortunately it can only be consumed in relatively small amounts without gastrointestinal distress from excessive gas.

23. Work has been done on the isolation of grass protein and green one-celled algae of the chlorella type, molds and bacteria grown in liquid culture have all been proposed for food but no one has yet succeeded in making these preparations palatable for large scale consumption. Preliminary estimates of nutritive value and cost have also been disappointing.

24. There is no doubt that increased quantities of fish and other sea food can be made available, particularly with modern refrigeration and frozen storage. Often the costs are beyond the means of large segments of the population of technically underdeveloped areas. Another means of increasing the availability of protein from fish is the more widespread use of freshwater fish ponds.

25. The proposal that has seemed most attractive, however, is the production of fish flour, using whole fish and particularly fish which would otherwise have little commercial value. Several processes have been developed and put into operation.

26. Thus far only foods from natural sources with or without the use of synthetic nutrients to improve them have been mentioned. The essential nutrients required by man are all chemical substances for which almost all the formulas are known. Most of them can already be synthesized or produced microbiologically but often only at an exhorbitant cost.

27. It seems certain that soon partially and even wholly synthetic foods will be competing in both palatability and nutritive value with foods of natural origin. Indeed, considering the use of artificial flavors and colors, hydrogenated fats, enrichment with synthetic nutrients, emulsifying agents and the like, this process has already begun.

## Food Safety

28. In the development of agricultural and food programs the safety of the food supply must be a primary concern. The increasing and necessary use of chemicals at all stages in the production and handling of foods is accompanied by hazards as well as advantages. Each new substance has potentially harmful as well as beneficial effects and the consumer must be protected from undesirable effects without discouraging or restricting the use of chemicals in ways that are beneficial.

29. Potentially hazardous materials enter the food chain not only by their intentional use in foods but also as unintentional food additives such as traces of pesticide, antibiotic and hormone residues, detergents used in cleaning containers, strontium 90 from radioactive fallout and many others.

30. A frequently overlooked fact is that most plants used for food by man already contain substances known to be toxic but the effects are minimized by conventional methods of handling them. Important among these are the trypsin inhibitor of raw soybeans which impairs protein digestion; the hemaglutins in many common legumes; the goiterogenic substances in plants of the cabbage family and in several common legumes; the potentially lethal cyanides of manioc (cassava or yucca); the cyanogenetic glucoside in the lima bean (Phaseola lunatus); the hypoglycin of the ackee fruit; gossypol and possibly other toxic materials in cottonseed meal; the active material of the broad bean (Vicia faba) which causes hemolytic anemia; the active principle in Lathyrus satirus responsible for lathyrism; and the high concentrations of oxalates in many common vegetables. In areas where these are commonly used, the harmful effects are minimized by cooking or other conventional methods of processing and consuming them. When they are

introduced into a new population, however, caution must be exercised to assure their safe use.

31. Methods of harvesting and storage of crops have also been shown to be important in the contamination of otherwise safe sources of food. Several instances of widespread toxicity have been the result of improperly stored grain and legumes which become moldy. The toxic agents in these cases were compounds produced by the molds which remained active throughout the various processing procedures. Thus it is important that the agricultural products used in foods be kept free from adverse effects of fungal as well as bacterial contamination.

32. Recognition of the problem of protecting the food supply in the U.S. is based on the concept that there are no harmless substances, but only harmless ways of using them. Until the compounds have specifically been shown to be safe, it is assumed that there is potential hazard from any chemical intentionally added, such as coloring and flavoring agents, anti-caking agents, emulsifiers, etc. The potential risk presented by such non-intentional additives as pesticide residues, antibiotic and hormone residues, detergents used in processing plants, materials migrating into foods from packaging materials, and strontium 90 and iodine 131 from radioactive fallout must be similarly evaluated. Again, in all specific instances the hazards must be recognized and appropriate measures taken to avoid contamination, remove the contaminant, or establish a tolerance level at which the contaminant may be present without danger.

33. The foregoing considerations make necessary continuing research in food toxicology, international exchange of information and standardization of food control regulations. WHO and FAO have already made considerable progress in this direction by convening a series of joint conferences and expert committees. FAO also issues summaries of food additive control regulations in various countries and a periodic bulletin listing new regulations introduced in any country. Each country must make provision for guarding the safety of its food supply in regard to food additives just as arrangements are now made for assuring the bacteriological purity and the safety of public water supplies.

## Changing Agricultural Practices and Food Habits

34. The introduction of higher yielding and more nutritious food crops, the initiation of modern agricultural practices, improvements in methods of food conservation, the development and use of new protein-rich foods, and achieving better dietary habits all require changes in long established customs and attitudes of people. Even with the help of social scientists, educators and government officials, this is not easily achieved.

35. Some cultures are proving relatively receptive to change; others are extraordinarily resistant. It is beyond the scope of this paper to discuss the ways in which cultural change is brought about but other papers presented in this meeting by social scientists place special emphasis upon it.

36. Action at a national level can sometimes be highly effective in the introduction of improved agricultural practices and food habits. Governments can help by making available such tools of change as improved seeds and animal varieties, agricultural chemicals, appropriate implements and machinery, storage and marketing facilities, agricultural credit and the like. For example, large investments are required in chemical fertilizer plants throughout the less developed areas; frequently these need to be provided or underwritten by national governments. Adequate rural credit at reasonable interest rates for the right kind of agricultural development is also of crucial importance. Sometimes a subsidy may be necessary to get a new crop or industry started or import restrictions may help national production to get a foothold.

37. Taxation policies relating to the importation of agricultural machinery, the purchase of parts for maintenance and of fuel may encourage or stifle its use. National planning councils, which have now been established in the majority of developing countries, need to be aware of necessary changes in agricultural and

food practices to meet the nutritional needs of their growing populations and to promote these in an orderly, rational manner.

38. Too often attention has been focused on major construction projects although these will not in themselves solve the problems of developing countries. Sometimes the objective seems to be the achievement of specific material evidences of progress. Roads, school and public buildings, dams and refineries are useful and necessary but they should not be ends in themselves.

39. Human needs should be the basis for formulating priorities and arriving at decisions as to the use of limited resources. Countries are not underdeveloped because they do not have the material evidences of progress but because they do not have the trained manpower to create them and maintain them without outside help. It is knowledge and know-how, and not primarily natural resources, which give the people of the highly developed countries of the West such a high standard of living and general welfare.

40. Education and training for all levels of the population are necessary to ensure that the developing countries come to share the benefits of scientific and technical knowledge. Programs of education and training need to be given first priority. Every country needs persons who are sufficiently well trained in nutrition and food science to adapt existing knowledge to the special needs and circumstances of their people. All need personnel who are well trained in agricultural extension and health education to teach others to apply this knowledge. Persons in developing countries must be taught to run and service agricultural and industrial machinery. Basic to the technical development of a country is a sufficient number of adequately trained primary school, secondary school and university teachers for its educational needs.

41. Effective government support of measures to improve agricultural and food practices is likely to come about only when the administrative officials and political leaders of a country themselves become aware of the true needs and possibilities for technical development. Government officials must understand the basic facts of science and technology if their economic and political decisions are to be the right ones.

42. Some personnel must also be devoted to research, in order to look for solutions to those problems for which ready solutions are not available from experience elsewhere. Moreover, no matter how much knowledge is available there is always need for more.

43. Lasting improvements in food and agriculture require technical knowledge to be disseminated throughout a society. It is the present strength of the so-called developed countries that they have achieved this to a considerable degree although the educational effort is a continuing one. The great hope and promise for the future of the underdeveloped countries is that they too can share in this knowledge and that they have both the human and natural resources to utilize it for the benefit of their peoples.

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

**SUMMARY**

Agenda Item: C.2

United States of America

# MEETING HUMAN NEEDS THROUGH AGRICULTURAL AND FOOD PRACTICES

By Nevin S. SCRIMSHAW,
Head of Department of Nutrition,
Food Science and Technology,
Massachusetts Institute of Technology,
Cambridge, Massachusetts

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

## NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

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# MEETING HUMAN NEEDS THROUGH AGRICULTURAL AND FOOD PRACTICES

Nevin S. Scrimshaw
Head of Department of Nutrition, Food Science and Technology
Massachusetts Institute of Technology
Cambridge, Massachusetts

1. Nearly all developing countries could successfully meet the nutritional needs of their populations by the application of available scientific and technical knowledge of the production, conservation, distribution and use of food. This would require the careful adaptation to local conditions of procedures found successful elsewhere, although there are many effective measures which governments and individuals can take immediately.

2. Food supplies can be increased by better conservation, including use of the older food preservation methods of drying, smoking, salting and thermal processing, as well as such newer procedures as refrigeration, freezing, vacuum drying and freeze drying. Antibiotic dips to extend shelf life and pasteurizing doses of ionizing radiation can also be employed. Construction of more adequate storage facilities, use of appropriate chemicals, newer packaging materials, improved sanitation and the more rapid and efficient distribution of food can prevent excessive losses due to rodents, insects and spoilage.

3. Enrichment of staple foods is a valuable and economical method of improving the nutritive value of the food supply. The enrichment of wheat flour with thiamine, riboflavin, niacin and iron has contributed to the disappearance of clinical vitamin deficiency disorders in the U.S. and a number of other countries. Similar enrichment of polished rice can eliminate beriberi from a region and corn meal so enriched will prevent the occurrence of pellagra. The addition of iodine to salt has helped to control endemic goiter in a number of countries. Possibilities for improving protein quality by supplying limiting amino acids in complementary foods or through the addition of synthetic amino acids should also be taken into account.

4. The introduction of new protein-rich foods for human feeding is another important way of meeting human nutritional needs in technically underdeveloped areas where the traditional protective foods are expensive and in short supply. The press cakes made from cotton, soya, sesame, sunflower seed, peanut and other oil seeds are particularly useful for combining with a cereal. Mixtures in which one-third of the protein comes from the oilseed meal, processed so as to minimize heat damage, and two-thirds from corn, sorghum, rice or wheat have a good protein value. Increased use of fresh fish from the sea or freshwater ponds is desirable. Flour made from whole fish can be an efficient source of protein readily available to many countries.

5. The increased use of chemicals in food and agriculture has been responsible for much of the increase in productivity per unit of land and per person engaged in agriculture, but chemicals may be misused in ways that create health hazards.



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Legislation and laboratory controls have been established in most of the developed countries; many other areas lack restrictions on the use of possibly hazardous substances in foods. Such curbs are necessary to protect the public from intentional and non-intentional additives of a harmful nature. Furthermore, many foods contain natural toxic substances and should be processed or consumed in ways which eliminate or minimize adverse effects.

6. Meeting human needs through improved agricultural and food practices requires both knowledge and the means to apply it. For nutrition education to be effective, additional and more varied foods must be made available at prices the people can afford.

7. Agricultural extension agents, health workers, school teachers and social workers are needed to teach desired agricultural and health practices including the fundamentals of nutrition. It is important that government officials responsible for economic and political decisions affecting food and agriculture have the necessary basic technical knowledge. Highly trained professionals in the various specialities of agriculture and nutrition are also required to conduct research, organize training programs and help adapt knowledge from other areas to local conditions.

8. The most important factor in the development of a country is the dissemination of technical knowledge throughout all professional and social levels of the population. For this reason developing countries should place primary emphasis on the various types of education and training.



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EN BENEFICIO DE LAS REGIONES MENOS DESARROLLADAS

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Punto del programa : C.1.2

Uruguay

# METAS DE PRODUCCION, CONSUMO Y EXPORTACION DE PRODUCTOS PECUARIOS EN EL URUGUAY

Por Alfredo L. WEISS,
Ingeniero Agrónomo,
Director del Instituto de Economía
de la Facultad de Agronomía,
Montevideo

Las monografías presentadas en la Conferencia de las Naciones Unidas sobre la Aplicación de la Ciencia y la Tecnología en Beneficio de las Regiones Menos Desarrolladas constituyen documentos de trabajo de dicha Conferencia. Se publican tal como han sido presentadas por los colaboradores y los puntos de vista expresados en ellas corresponden a los colaboradores. (Veanse notas al dorso.)

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# METAS DE PRODUCCION, CONSUMO Y EXPORTACION DE PRODUCTOS PECUARIOS EN EL URUGUAY.-

Autor: Director del Instituto de Economía de la Facultad de Agronomía, Ing.Agr.Alfredo L. Weiss.- **Montevideo - URUGUAY**

El estudio de metas fectibles de producción, consumo y exportación de productos pecuarios en el Uruguay a mediano y largo plazo, pretende ser una contribución a la programación del sector agrícola dentro de la Programación del Desarrollo Económico que se inicia en estos momentos en este país.-

El análisis se basa en otros estudios anteriores del autor: Reforma Agraria 1942, y Plan Agropecuario 1946, así como en trabajos de la División F.A.O.CEPAL de los cuales participó durante los años 1960 y 61, (E/CN.12/594 y E/CN.12/620-1962) en que se estableció la dimensión de los principales factores limitantes de la Producción Pecuaria del Uruguay, diseñándose las medidas primarias que sería necesario adoptar para su promoción.-

Las metas que se consignan se supone que pueden ser alcanzadas utilizando los instrumentos que fueron esbozados en los trabajos mencionados, y que van a ser objeto de riguroso reexamen por parte de los expertos nacionales y extranjeros que ya han iniciado el análisis económico previo a la Programación de la Economía Nacional.-

Si la elección de los instrumentos y políticas fueran adecuados, y apropiadas las metas, determinadas en este estudio, restaría establecer las inversiones que demandaría la aplicación de los primeros y el cumplimiento de las segundas.-

Las proyecciones concretadas para el corto y mediano plazo toman como año base 1959, como meta intermedia 1965 y como meta final al año 1970, y para elaborarlas se realizaron análisis en relación con los siguientes productos: carne vacuna, carne ovina, carne de cerdo, carne de ave, huevos, leche y productos lacteos, lana y pescado.-

Para la proyección de los consumos se tomó en cuenta principalmente el crecimiento previsto de la población, la tasa de crecimiento del ingreso y la tendencia de los respectivos precios.

Para la proyección de cada una de las producciones se consideraron coeficientes de productividad, situados siempre por debajo de aquellos que cabe esperar de una efectiva coyuntura técnico-económica, y basados en niveles ampliamente superados en diversas fincas pioneras 'tipo', de distintas regiones del país.

Para la proyección de las exportaciones, tanto en el caso de la carne como de la lana se partió del supuesto de que hasta límites prudenciales seguirán existiendo mercados para ambos rubros una vez que se ajusten las relaciones entre el Mercado Común Europeo y la Asociación Latino Americana de Libre Comercio y se expanda asimismo el comercio Inter-Americano. En cuanto a los volúmenes de exportación previstos para la carne no excederían en 1970 de los que ya se alcanzaban muchos años atrás, y que se deterioraron por el incremento del consumo interno.-

URUGUAY : Metas Tentativas de Consumo de Alimentos de Origen Animal en 1965 y 1970

| | 1959 | | 1965 | | 1970 | |
|---|---|---|---|---|---|---|
| | miles de tons | Ks.por hab.año | miles de tons | Ks.por hab.año | miles de tons | Ks.por hab.año |
| Carne vacuna | 174 | 62.4 | 188 | 62.4 | 201 | 62.4 |
| Carne ovina | 58 | 20.9 | 76 | 25.0 | 94 | 29.0 |
| Carne de cerdo | 19.7 | 7.0 | 24.3 | 8.0 | 29.4 | 9.1 |
| Carne de ave | 13 | 4.7 | 18.1 | 6.0 | 23.2 | 7.2 |
| Pescado | 5.6 | 2.0 | 10.6 | 3.5 | 16.1 | 5.0 |
| Carnes y pescado | 270.3 | 97.0 | 317.0 | 104.9 | 363.7 | 112.7 |
| Leche | 666 | 238 | 752 | 249 | 841 | 261 |
| Huevos(millones unidades) | 350 | 125 | 415 | 137,5 | 484 | 150 |

URUGUAY : Metas Tentativas de Exportación de Productos Pecuarios en 1965 y 1970
(miles de dólares)

| | 1959 | 1965 | % sobre 1959 | 1970 | % sobre 1959 |
|---|---|---|---|---|---|
| Carne Vacuna | 15.433 | 37.552 | 144 | 58.080 | 276 |
| Carne Ovina | 342 | 2.680 | 683 | 5.360 | 1.467 |
| Prod.Lácteos | - | 10.000 | - | 20.000 | - |
| Lana | 54.200 | 91.000 | 68 | 113.000 | 109 |
| Cueros Vacunos | 6.096 | 9.462 | 52 | 9.659 | 59 |
| Cueros o Pieles lanares | 3.122 | 6.472 | 109 | 7.669 | 148 |
| TOTAL | 79.193 | 156.966 | 98 | 213.768 | 170 |

URUGUAY : Metas Tentativas de Producción Pecuaria en 1965 y 1970
(miles de toneladas)

| | 1959 | 1965 | % sobre 1959 | 1970 | % sobre 1959 |
|---|---|---|---|---|---|
| Carne Vacuna | 206 | 266 | 32 | 321 | 58 |
| Carne Ovina | 59.4 | 86 | 45 | 114 | 92 |
| Carne de Cerdo | 19.7 | 24.3 | 23 | 29.4 | 49 |
| Carne de Ave | 13 | 18.1 | 39 | 23.2 | 78 |
| Pescado | 5.6 | 10.6 | 89 | 16.1 | 187 |
| Total Carnes y Pescado | 303.7 | 405.0 | 33 | 503.7 | 66 |
| Leche | 666 | 952 | 43 | 1.241 | 86 |
| Huevos(millones unidades) | 350 | 415 | 19 | 484 | 38 |
| Lana | 80 | 103 | 29 | 126 | 58 |



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Una Meta a más Largo Plazo.

Una meta a más largo plazo podría consistir en alcanzar progresivamente el nivel de los índices de productividad de Nueva Zelandia.

Es posible basarse en muy buenas razones para pensar que ese ideal es factible.

Tomando en consideración la superficie de praderas de que depende cada país resultaría el siguiente volúmen de la producción pecuaria, de ambos países.

| PRODUCTO | Ks.por ha.-año (Indice de productividad de N.Z.) (1958) | N.Zelandia Vol.total mill.Ks. | Uruguay Vol.total mill.Ks. |
|---|---|---|---|
| Carne Vacuna | 21.9 | 277 | 325 |
| Carne Ovina | 27 | 341 | 401 |
| Lana | 19.4 | 245 | 287 |
| Leche | 11.6 | 5.100 | 5.397 |

El volúmen de la producción pecuaria hipotética para el Uruguay aparece como superior al obtenido por Nueva Zelandia en 1958, o sea en el año tomado como base para estas comparaciones, en función de que este país dispone de una menor superficie de praderas (12.623.000 Has)

Trasladando al Uruguay los rendimientos de Nueva Zelandia la producción pecuaria de aquel habría podido generar la exportación de los siguientes volúmenes y valores en dólares de los productos que se enumeran:

| | Toneladas | Millones de dólares |
|---|---|---|
| Carne Vacuna | 151.000 | 62.9 |
| Carne Ovina | 343.000 | 78.5 |
| Leche (productos lácteos) | 4.768.000 | 238.4 |
| Lana | 276.000 | 276.0 |
| TOTAL | - | 655.8 |

Una exportación del Uruguay de tal volúmen sobrepasaría en 659 % la correspondiente a todos los productos pecuarios, en 1959, que sumó 86.4 millones de dólares; y en 207 %, la proyección de la meta tentativa de exportaciones pecuarias para 1970, prevista por este estudio.-

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Montevideo, Setiembre 15/962.-

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SUMMARY
19 Nov.1962
ENGLISH
ORIGINAL : SPANISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

**SUMMARY**

Agenda Item: C.1.2

Uruguay

# PRODUCTION, CONSUMPTION AND EXPORT AIMS OF LIVESTOCK PRODUCTION IN URUGUAY

By Alfredo L. WEISS,
Agronomical Engineer,
Director of the Institute of Economics
of the Faculty of Agronomy,
Montevideo

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

## NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

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# PRODUCTION, CONSUMPTION AND EXPORT AIMS OF LIVESTOCK PRODUCTION IN URUGUAY

By

ALFREDO L. WEISS, AGRONOMICAL ENGINEER, DIRECTOR OF THE INSTITUTE OF ECONOMICS OF THE FACULTY OF AGRONOMY, MONTEVIDEO

The study of medium and long-term aims achievable in the production, consumption and export of livestock produce in Uruguay is intended to be a contribution to the planning of the agricultural sector within the General Planning of Economic Development, preliminary work on which is now starting in our country. This survey is based upon previous studies in which the author took part: Land Reform 1942; Land and Cattle Plan 1946; and Prospects of Livestock in Uruguay 1960/61 (F.A.O. Division -CEPAL E/CN.12/594-1961 and E/CN.12/620-1961), in which the size of the main limiting factors in the output of animal produce in Uruguay was established, laying down the primary measures which it would be necessary to adopt to bring it about. It is assumed that the aims stated can be attained by using the instruments outlined in the above mentioned works, and which will be made the subject of very close re-examination by both home and foreign experts, who have already started the economic survey prior to the Planning of the National Economy. If the choice of instruments and policies were adequate, and appropriate to the achievement of the aims laid down in this survey, it would remain to determine the investments required for the application of the former and the carrying out of the latter. The concrete form of the short and medium term programmes takes 1959 as a basis, 1965 as an intermediate goal and the year 1970 as the final goal. To draw up this programme, a survey was made in connection with the following produce: beef and veal, mutton and lamb, pork, chicken, eggs, milk and milk products, wool and fish.

URUGUAY: Tentative Aims for Consumption of Foodstuffs of Animal Origin for 1965/70.

| | 1959 | | 1965 | | 1970 | |
|---|---|---|---|---|---|---|
| | thousand metric tons | kg. per inhab.year | thousand metric tons | kg. per inhab.year | thousand metric tons | kg.per inhab. year |
| Beef/Veal | 174 | 62.4 | 188 | 62.4 | 201 | 62.4 |
| Mutton and lamb | 58 | 20.9 | 76 | 25 | 94 | 29.4 |
| Pork | 19.7 | 7.0 | 24.3 | 8.0 | 29.4 | 9.1 |
| Chicken | 13 | 4.7 | 18.1 | 6.0 | 23.2 | 7.2 |
| Fish | 5.6 | 2.0 | 10.6 | 3.5 | 16.1 | 5.0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Meat and fish | 270.3 | 97.0 | 317.0 | 104.9 | 363.7 | 112.7 |
| Milk | 666 | 238 | 752 | 249 | 841 | 261 |
| Eggs (by thousands) | 350 | 125 | 415 | 137.5 | 484 | 150 |

URUGUAY: Tentative Aims for Export of Livestock Produce in 1965/70
(thousand dollars)

| | 1959 | 1965 | % of 1959 | 1970 | % of 1959 |
|---|---|---|---|---|---|
| Beef | 15,433 | 37,552 | 144 | 58,080 | 276 |
| Mutton and lamb | 342 | 2,680 | 683 | 5,360 | 1,467 |
| Milk Products | - | 10,000 | - | 20,000 | - |
| Wool | 54,200 | 91,000 | 68 | 113,000 | 109 |
| Cattle Hides | 6,096 | 9,262 | 52 | 9,659 | 59 |
| Hides or Skins from sheep | 3,122 | 6,472 | 109 | 7,669 | 148 |
| TOTAL | 79,193 | 156,966 | 98 | 213,768 | 170 |

A Longer Term Aim. A longer-term aim might be to progressively attain the level of productivity indices of New Zealand. There are very good reasons considering this ideal feasible. Taking into consideration the area of pasture land on which each country depends, the following volume of livestock production is arrived at for both countries:-

| PRODUCE | kg. per hectare per annum (Productivity index of N.Z.) (1958) | N.Zealand Total vol. Million kg. | Uruguay Total vol. million kg. |
|---|---|---|---|
| Beef and veal | 21.9 | 277 | 325 |
| Mutton and lamb | 27 | 341 | 401 |
| Wool | 19.4 | 245 | 287 |
| Milk | 11.6 | 5.100 | 5.397 |

The volume of the presumed livestock production for Uruguay is shown to be higher than that achieved by New Zealand in 1958, (i.e. the year which has been taken as a basis for these comparisons) by reason of the fact that this country possesses a smaller area of pasture land (12,623,000). By applying to Uruguay the output of New Zealand, the livestock production of the former could have enabled the following quantities and dollar values of the produce named to be exported:

| | Metric Tons | Million dollars |
|---|---|---|
| Beef and veal | 151,000 | 62.9 |
| Mutton and lamb | 343,000 | 78.5 |
| Milk (milk products) | 4,768,000 | 238.4 |
| Wool | 276,000 | 276.0 |
| TOTAL | - | 655.8 |

The export from Uruguay of such a volume would exceed by 659% the export of all livestock produce in 1959 (which amounted to 86.4 million dollars) and by 207% the tentative aim of livestock exports estimated for 1970 in accordance with the present survey.

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CONFERENCIA DE LAS NACIONES UNIDAS
SOBRE LA APLICACION DE LA CIENCIA Y LA TECNOLOGIA
EN BENEFICIO DE LAS REGIONES MENOS DESARROLLADAS

Punto del programa : C.1.3

Organización de las Naciones Unidas
para la Agricultura y la Alimentación

# ROL DE LA EXTENSION AGRICOLA EN LA APLICACION DE LA CIENCIA Y LA TECNOLOGIA

Por Enrique A. SUMMERS,
Jefe de la Sub-División de Educación
y Extensión Agrícolas,
División de Instituciones
y Servicios Rurales, F.A.O.

Las monografías presentadas en la Conferencia de las Naciones Unidas sobre la Aplicación de la Ciencia y la Tecnología en Beneficio de las Regiones Menos Desarrolladas constituyen documentos de trabajo de dicha Conferencia. Se publican tal como han sido presentadas por los colaboradores y los puntos de vista expresados en ellas corresponden a los colaboradores. (Veanse notas al dorso.)

## NOTAS

1. Las monografías seleccionadas para las Sesiones Generales serán distribuidas en la Conferencia en los siguientes idiomas oficiales de las Naciones Unidas: español, francés, inglés y ruso.

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3. Los resúmenes de las monografías presentadas por los colaboradores serán distribuidos en la Conferencia en los siguientes idiomas oficiales de las Naciones Unidas: español, francés, inglés y ruso.

4. No se procederá a la distribución general de las monografías y resúmenes con antelación a la Conferencia. Unicamente serán publicadas en cantidades limitadas con antelación a la Conferencia para uso exclusivo de las delegaciones de los gobiernos participantes y de otros participantes autorizados. La publicación con posterioridad a la Conferencia y la distribución general de las actas y debates de la Conferencia seguirán las prácticas de las Naciones Unidas establecidds por ia Junta de Publicaciones de las Naciones Unidas.

# ROL DE LA EXTENSION AGRICOLA EN LA APLICACION DE LA CIENCIA Y LA TECNOLOGIA

por Enrique A. Summers, Jefe de la
Sub-división de Educación y Extensión Agrícolas
División de Instituciones y Servicios Rurales
F.A.O.

## 1. Función de los Servicios de Extensión.-

La divulgación de los nuevos conocimientos y de los métodos de producción resultantes del desarrollo de la ciencia y la tecnología agrícolas, con el objeto de lograr su aplicación oportuna y por lo tanto su más rápido aprovechamiento, es la esencia misma del trabajo de extensión agrícola. Con el término extensión se designa el proceso educativo informal, extra-escolar, destinado a instruir y asistir al agricultor y su familia y en general al medio rural, en aquellas materias y actividades que son necesarias para promover el mejoramiento de su producción y la elevación de su nivel de vida. Los servicios de extensión son los organismos creados para desarrollar esta tarea. Estos son organismos eminentemente rurales que desarrollan sus actividades en las tierras y en el ambiente en que moran los agricultores, utilizando métodos y procedimientos propios que están en concordancia con su modalidad de trabajo; son el vehículo mediante el cual se llevan y se demuestran al hombre del campo los conocimientos prácticos más aparentes, y particularmente los nuevos descubrimientos de la ciencia y la tecnología, debidamente expresados en la forma simple y objetiva más comprensible para el agricultor; sus objetivos fundamentales son promover y facilitar la acción individual y de grupo en pro de un mayor y más rápido progreso del medio rural.

## 2. Carácter Dinámico de la Extensión.-

La extensión es un factor de progreso y conserva esta característica manteniéndose a la vanguardia del medio donde actúa, para lo cual se surte de los últimos descubrimientos resultantes de la investigación. Se admite universalmente que la investigación agropecuaria debe ser un proceso permanente y dinámico por el hecho de ser efectuado sobre seres vivientes capaces de continuos cambios y adaptaciones a condiciones variables y por su íntima relación con otras ciencias básicas cuyo desarrollo le abre frecuentemente nuevas y vastas oportunidades, tanto en el campo vegetal como en el animal. La extensión agrícola es, en medida considerable, un proceso consecuente y complementario de la investigación y estando destinado a procurar la más rápida y amplia aplicación de los descubrimientos disponibles, debe conservar un ritmo aparente y tener también un carácter

esencialmente dinámico. La extensión procura la introducción de cambios en los procedimientos y en la actitud de los agricultores, procura convertir las situaciones estáticas prevalentes en el medio rural en situaciones dinámicas, provocando la iniciación de corrientes de progreso y asistiendo en su desarrollo. Debe, pues, llevar en sí la misma característica que pretende transmitir. El grado de dinamismo de un servicio de extensión está determinado por la calidad de su personal, por las facilidades de que dispone para realizar su trabajo, por la cercanía de sus relaciones con las fuentes de conocimientos y por la efectividad de su cooperación con otros servicios destinados a la población rural. En consecuencia, la apropiada atención de estos aspectos es requisito indispensable para que un servicio de extensión se ubique y se mantenga como factor constante de progreso.

3. La Extensión es el Complemento Indispensable de la Investigación.-

(a) Por lo general, en los países agrícolamente avanzados este concepto es claramente entendido y se refleja en la organización y en las relaciones de las instituciones encargadas de hacer investigaciones en el campo de la agricultura y de divulgar los resultados obtenidos. En muchos de los países en desarrollo, los servicios e instituciones de investigación han sido organizados y funcionan con mayor o menor eficiencia desde hace un número apreciable de años, siendo relativamente frecuentes los trabajos útiles y los descubrimientos de valor efectuados por investigadores agrícolas de excelente preparación. Sin embargo, es caso frecuente en dichos países que trabajos y descubrimientos útiles no se lleguen a aplicar en una proporción que afecte en forma apreciable la situación de los agricultores, especialmente de los pequeños agricultores que constituyen la mayoría. No se cumple el objetivo que se tuvo al hacer los esfuerzos empleados en avances científicos y tecnológicos si no se logra una vasta aplicación de los resultados aprovechables. Un investigador eminente expresó en una reunión que si se llegara a aplicar sólo el 10% de los conocimientos acumulados en los archivos de la estación experimental de la cual era director, podría duplicarse la producción agrícola de su país. Vale añadir que esta cita proviene de un país que al presente tiene serios problemas para conservar siquiera un nivel de subsistencia en parte considerable de su población. Situaciones como la mencionada son frecuentes en los países en desarrollo; se obtienen y se acumulan conocimientos útiles, pero no se hacen suficientes esfuerzos para lograr su aplicación. La obtención de resultados positivos no es por ningún motivo el paso final en los trabajos de investigación agrícola aplicada, que es la que normalmente se conduce en los países menos avanzados. El trabajo queda sin terminar y por lo tanto sin haber cumplido su objetivo, si los descubrimientos hechos no llegan a ser aplicados por un porcentaje apreciable de los agricultores del país. Esta tarea de diseminación es la que le toca cumplir a los servicios de extensión.

(b) Pero el papel complementario de los servicios de extensión con relación a la investigación va más allá de la diseminación de los resultados. Debido a la gran variabilidad de los suelos, micro-climas, mercados y precios entre varias localidades, los resultados de la investigación tienen que ser verificados en muchos lugares para determinar su validez local. Esta tarea, desarrollada en forma que no represente riesgos mayores para los agricultores, la ejecutan usualmente los servicios de extensión.

(c) Por otra parte, los servicios de extensión están en la mejor posición para recoger los problemas de importancia que afectan sus áreas de acción y transmitirlos a las estaciones experimentales para su solución. Este es un proceso de doble vía entre la investigación y la extensión que puede contribuir eficazmente a una mayor orientación de los programas de las estaciones experimentales hacia la solución de los problemas actuales y más apremiantes de los agricultores.

(d) El hecho de ser actividades complementarias y en cierto grado interdependientes demanda, pues, el establecimiento de relaciones estrechas entre la investigación y la extensión y la mutua participación en la elaboración de los programas de trabajo respectivos.

4. Utilización de los Descubrimientos Provenientes de Otros Países.-

Aparte de los trabajos y descubrimientos locales en el campo de la ciencia y la tecnología agrícolas, existe a la libre disposición de todos un cúmulo enorme de conocimientos provenientes de otros países y regiones. La investigación agrícola tiene la virtud de que una parte considerable de sus hallazgos son o pueden ser de aplicación universal. En los últimos años hemos sido testigos de desarrollos dramáticos en materias tales como insecticidas, fungicidas, herbicidas, fertilizantes, maquinaria agrícola, procesado y conservación de cosechas, productos veterinarios, nutrición animal, fitotecnia, zootecnia, etc. Parte muy apreciable de los descubrimientos y de los productos resultantes de este gran esfuerzo en investigación son aplicables en todas o casi todas las condiciones de ambiente existentes en el mundo. El intercambio internacional de conocimientos es generalmente reconocido y abundantemente efectuado en el campo de la agricultura. Por fortuna, la agricultura es un campo donde no se guardan mayormente secretos entre científicos e investigadores y la difusión de los nuevos conocimientos entre esta clase de personas está ampliamente garantizada por el gran número de publicaciones técnicas que se produce en el mundo y por la frecuencia con que se conducen seminarios y eventos destinados al intercambio científico en materias de agricultura. Esto aumenta en forma considerable el bagaje de conocimientos disponibles a los servicios de extensión para el mejor cumplimiento de su cometido. Es verdad que siempre se requiere la ejecución de ensayos para determinar la validez para una localidad de los descubrimientos procedentes de otros países y regiones, o para determinar los métodos más aparentes de aplicación, pero este es un trabajo relativamente rápido y fácil de ejecutar. Ciertos descubrimientos sólo requieren pequeñas adaptaciones para ser aplicables en condiciones muy variables. Desde luego, en este proceso los servicios de extensión deben ser cautelosos y actuar en consulta y en coordinación con los centros de investigación, pero el número de oportunidades que ofrece a los países en desarrollo la adaptación o adopción de descubrimientos provenientes de fuentes extranjeras es prácticamente interminable. Las instituciones nacionales responsables por el desarrollo de la agricultura en los países menos avanzados, deberían dar a esta materia una atención preferencial, mediante programas combinados de experimentación aplicada y extensión.

5. Accesibilidad de la Información Disponible.-

Puesta en su expresión más simple, la tarea fundamental de los

servicios de extensión es hacer accesible para el agricultor la información técnica u otra información útil que está disponible para aplicación inmediata. Precisamente el término extensión fue originalmente adoptado para expresar el proceso de extender al público agricultor la enseñanza de las facultades y colegios de agricultura y los descubrimientos de sus estaciones experimentales, en el entendimiento de que el hombre del campo no está normalmente en posición de acudir a dichos centros en busca de la información que necesita. Desde el punto de vista de la extensión, la accesibilidad de los conocimientos debe entenderse en dos sentidos:

(a) La Ubicación de las Fuentes de Información.- Aún aceptando que el público está interesado en acudir a las estaciones experimentales, bibliotecas y oficinas técnicas, etc., no es generalmente posible lograr la afluencia de agricultores provenientes de todos aquellos sectores agrícolas que deben estar enterados de los conocimientos existentes en dichos centros o que en una u otra forma pueden beneficiarse con ellos, que es necesaria para divulgar suficientemente un descubrimiento. Factores tales como distancias, disponibilidad de tiempo para acudir durante las horas en que funcionan los centros proveedores de información, conocimiento de la existencia de dichos centros y de su disponibilidad para el público, timidez y en muchos casos recelo en el medio rural con respecto a las instituciones oficiales, etc., limita la afluencia de los agricultores a un grado mínimo en relación con el total de la población agrícola. Ha sido frecuente, y en algunos lugares continúa siéndolo, en países carentes de servicios de extensión o en los que estos están escasamente desarrollados, que la información útil en el campo de la agricultura haya estado casi exclusivamente al alcance de los agricultores grandes o de mayor holgura económica. Este tipo de agricultor tiene generalmente el tiempo, la posición social y el conocimiento de la existencia de los centros de información y sus líneas de trabajo que son necesarios para despertar su interés e inducirlo a acudir por sí solo a dichos centros y también para esperar que los técnicos u oficiales encargados le den atención adecuada. En cambio, el campesino o el pequeño agricultor, que carece de esos elementos, requiere fuentes de información más cercanas y más adaptadas a su ambiente y no se siente atraído a instituciones agrícolas de carácter más o menos formal o muy apartadas de su lugar de trabajo.

(b) Forma en que la Información Disponible es Expresada.- Lo común es que la información proveniente de los centros de investigación esté expresada en forma inteligible para el técnico y en ciertos casos para personas con una cultura general apreciable. En esa forma la información es accesible sólo para un reducido número de personas y no está al alcance de los conocimientos limitados y de la escasa cultura de la gran mayoría de los agricultores. Este punto es de extrema importancia y encierra en sí el propósito básico de la extensión y la necesidad de que las personas que trabajan en extensión tengan la preparación adecuada en los procedimientos y métodos propios de este proceso educativo informal, a la vez que una preparación técnica adecuada en las materias agrícolas y ganaderas prevalentes en su área de trabajo. La información escrita es sin duda alguna un arma útil siempre que lo que se quiera relatar esté expuesto en forma atractiva e inteligible para el medio rural, en los términos y con el sentido práctico que el agricultor requiere. Sin embargo, es muy frecuente el caso de regiones agrícolas donde gran parte de los agricultores son analfabetos y donde para enseñar es necesario utilizar métodos claramente objetivos. El más efectivo y por lo tanto el más frecuente de los métodos que se emplean en extensión es la demos

tración, en otras palabras enseñar haciendo y mostrando resultados. Para esto se requiere un conocimiento cabal de la materia que se enseña a la vez que de las técnicas de enseñanza apropiadas para el grupo al cual va dirigida. Es conveniente anotar que la extensión no es un proceso dirigido a una clase sola de agricultores y por este motivo debe adaptar sus procedimientos al medio donde actúa, pero el medio más numeroso al mismo tiempo que el más necesitado de ayuda es el medio campesino y de pequeños agricultores, en el cual el nivel de educación es mínimo.

(c) Los servicios de extensión están dirigidos y organizados para salvar las situaciones y dificultades expuestas y no sólo cumplen el papel de diseminar información sino que también asisten al agricultor en su aplicación y procuran crearle y mantenerle vivos, a base de realizaciones, el interés, la esperanza y la confianza que son necesarios para motivar mayores esfuerzos de progreso. En consecuencia, si la aplicación de los descubrimientos en el campo de la ciencia y de la tecnología agrícolas es necesaria para el progreso de un país, dichos descubrimientos deben ser accesibles a la totalidad o a la mayoría de los agricultores y para esto se requiere la existencia de organismos preparados para hacer efectiva tal accesibilidad, en otras palabras, se requieren servicios de extensión suficientemente amplios y habilitados, cuyo personal esté debidamente capacitado en las técnicas más aparentes de divulgación.

6. Conveniencia del Establecimiento de un solo Servicio de Extensión de Carácter General.-

Ya se ha discutido la necesidad de que la divulgación de conocimientos en el medio agrícola sea hecha por personas entrenadas en métodos educativos apropiados al ambiente rural. Por otra parte, para desarrollar este proceso educativo se requiere un organismo apropiado y debidamente equipado para el propósito. La experiencia indica que las instituciones técnicas dedicadas a la investigación no están en capacidad de efectuar la divulgación de sus descubrimientos con la efectividad, la amplitud y en el nivel que son necesarios. Por otra parte, el desempeño de actividades de extensión por organismos especializados en materias técnicas específicas demandaría de esfuerzos que sería muy difícil costear dada la gran variedad de campos que dichas actividades comprenden. Sin embargo, existe aún la tendencia en ciertos organismos especializados, por razones de falta de una coordinación adecuada, de desconfianza en los servicios de extensión y en algunos casos por celos en el campo profesional, de realizar por sí solos la tarea de extensión. Esta forma de proceder es en muchos casos el origen de una divulgación defectuosa tanta en área como en profundidad. El técnico de investigación no está generalmente capacitado en los métodos de enseñanza que son necesarios para poner los nuevos conocimientos al alcance de los agricultores; el carácter especializado de sus conocimientos lo orienta a atribuir la mayor importancia, quizás excesiva, a su materia de trabajo, descuidando los demás factores que intervienen en el complejo de una explotación agrícola; la presencia de varios técnicos especializados trabajando independientemente en un mismo lugar da origen en muchos casos a recomendaciones controversiales que son causa de confusión en el medio rural y reducen la efectividad del trabajo de divulgación. Esta forma de acción limita también la capacidad para seguir otorgando ayuda al agricultor en materias conexas o que se deriven de la aplicación de una práctica en un campo especializado. Los servicios de extensión

generalizados están dirigidos a otorgar una asistencia global, teniendo en cuenta las explotaciones agrícolas o ganaderas como un conjunto de operaciones de carácter técnico, económico y social y otorgando prioridades adecuadas a las diversas actividades que constituyen ese conjunto. La continua observación y estudio del medio donde actúa pone al técnico de extensión en posición de determinar con un grado aceptable de acierto aquellos campos en los cuales el desarrollo de actividades específicas va a determinar el mayor progreso. Los servicios de extensión requieren con frecuencia la participación de especialistas para ayudar a sus técnicos en la solución de ciertos problemas específicos y al ser realizadas a través de las oficinas rurales de extensión, las actividades de esos especialistas resultan más efectivas y de mucho mayor alcance. Como técnico, el funcionario de extensión puede recibir e interpretar adecuadamente los conocimientos que le transmite el especialista sobre un problema determinado y divulgarlo luego en forma amplia, utilizando métodos aparentes. En algunos casos la inclusión de especialistas dentro de la misma organización de extensión es necesaria y posible. En otros, lo esporádico de su acción o la falta de personal especializado hace poco recomendable o imposible ubicar ciertos especialistas como empleados a tiempo completo de un servicio de extensión. En todo caso, la participación de especialistas en el trabajo de extensión es necesaria y puede ser realizada mediantes técnicos propios de un servicio de extensión o mediante una colaboración bien establecida entre estos y los centros de investigación. Existen ejemplos abundantes y muy ponderables de este tipo de colaboración. Para que suceda, se requiere que ambos servicios comprendan la interdependencia de su acción y mantengan relaciones estrechas. Los resultados no pueden ser sino favorables para ambos y desde luego para el país. Si se considera la escasez de recursos tanto de personal como financieros, la situación prevalente en las áreas rurales, y la necesidad de dirigir las actividades oficiales hacia todos los problemas que impiden o que estorban en grado considerable el desarrollo agrícola de un país, la forma comprensiva y coordinada de divulgación de la ciencia y la tecnología agrícolas que realizan los servicios de extensión resulta ser la más apropiada y con toda probabilidad la única recomendable, particularmente para los países en proceso de desarrollo.

7. Factores que Determinan la Efectividad de los Servicios de Extensión.-

En párrafos anteriores se han discutido algunos de los factores que contribuyen al mejor desarrollo de las actividades de extensión, se trata en este capítulo de puntualizar los aspectos que requieren mayor atención, particularmente en aquellos países donde los servicios de extensión son recientes o donde por causas diversas no están recibiendo el soporte que es necesario.

(a) Capacitación del Personal.- El contar con personal debidamente preparado tanto en los aspectos técnicos de la agricultura como en los aspectos educacionales y sociales necesarios para el trabajo de extensión, es el factor de mayor importancia para la efectividad de los servicios de extensión. En la mayoría de los países las facultades y escuelas de agricultura no incluyen cursos en materias sociales y en los aspectos correspondientes al trabajo de extensión. Esta situación se ha estado remediando con la organización de cursillos especiales y centros de capacitación tanto nacionales como

internacionales y a este respecto las agencias internacionales y programas de ayuda bi-lateral han desarrollado actividades provechosas en varios países y regiones. Sin embargo, es evidente aún la necesidad de realizar mayores esfuerzos, especialmente en la organización de actividades de capacitación de orden nacional. En la organización de dichas actividades, se debe tener en cuenta también que un técnico de extensión necesita recibir constantemente preparación adicional y en concordancia con los avances de la ciencia y la tecnología agrícolas. Las siguientes medidas pueden contribuir a una mejor preparación del personal que al presente se dedica a trabajar en extensión y de aquel que se intenta emplear para cubrir vacantes o para cumplir con la expansión de los servicios a todas las áreas necesitadas de un país.

(i) Centros especiales de capacitación en extensión agrícola.

(ii) Cursillos periódicos para refrescar conocimientos y para informar al personal de extensión sobre los avances logrados por las estaciones experimentales y otros centros de estudios.

(iii) Introducción de cursos en las ciencias sociales y en los diversos aspectos correspondientes al trabajo de extensión en las facultades y escuelas de agricultura.

(iv) Establecimiento de un sistema de cooperación entre las facultades y escuelas de agricultura y los servicios de extensión para que grupos de alumnos de los últimos años reciban durante el tiempo de vacaciones, períodos de "capacitación en servicio" como asistentes de las oficinas rurales de extensión. Este sistema ha sido ensayado con marcado éxito en varios países y no se refiere exclusivamente al entrenamiento de futuros funcionarios técnicos de extensión sino también de especialistas en materias específicas.

(b) <u>Facilidades de Trabajo en las Oficinas de Extensión</u>.- El segundo punto en orden de importancia es permitir a un técnico bien preparado desarrollar su trabajo con la amplitud y la eficiencia que son necesarias. Un técnico de extensión está al servicio de un área frecuentemente extensa y debe por lo tanto estar en capacidad de movilizarse con facilidad en toda su área de trabajo. La provisión de elementos apropiados de transporte es, pues, indispensable para la efectividad de un servicio. Además, siendo la demostración el método más usual de trabajo, es necesario disponer del equipo conveniente y de los materiales que se requieren para efectuar dichas demostraciones. Estos aspectos constituyen al presente un serio problema en muchos servicios de extensión y es urgente que las instituciones respectivas pongan la debida atención en la solución de dichos problemas. Servicios de extensión paralizados por falta de facilidades de trabajo resultan una carga para el estado y un pobre ejemplo de la acción oficial con respecto a la agricultura, en lugar del elemento de progreso que se supone que son. Los servicios de extensión, en mucho mayor grado que otras instituciones agrícolas, están expuestos continuamente a la observación y a la crítica por parte de los agricultores, crítica que necesariamente se proyecta hacia las instituciones de las cuales dependen. Conviene anotar que la extensión constituye en muchos lugares el único servicio agrícola que reciben las áreas rurales.



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(c) Asistencia de Especialistas.- La organización de un cuerpo de especialistas dentro de los servicios de extensión es una medida necesaria para dar la debida asistencia a los técnicos de conocimientos más generales que se emplean para ejecutar el trabajo de extensión agrícola. Sin embargo, por motivo de recursos y también en muchos casos por escasez de personal no es posible organizar dichos cuerpos de especialistas en forma que satisfaga todas las necesidades de un servicio. Para solucionar este problema se recomienda el establecimiento de relaciones con los centros de investigación, cuyos técnicos pueden, en ciertos casos, disponer del tiempo que es necesario para actuar también como especialistas del servicio de extensión. Esta forma de acción da la oportunidad de estrechar las relaciones entre la extensión y la investigación.

(d) Establecimiento o Refuerzo de los Programas con las Juventudes Rurales.- Se ha discutido la acción favorable de extensión en la divulgación de conocimientos entre los agricultores adultos. Por su importancia, es necesario mencionar en forma particular el trabajo de extensión con las juventudes rurales. El proceso educativo de la extensión en este sector de la población resulta ser un complemento extremadamente útil de la educación que imparten las escuelas y está especialmente dirigido a familiarizar e instruir al joven rural en aquellas materias agrícolas de orden práctico hacia los cuales demuestra inclinación. La experiencia de muchos países indica que la divulgación de nuevos descubrimientos en materias de agricultura encuentra el medio más receptivo en la juventud rural y que la influencia de ésta puede ser notoria en el proceder y la actitud de los adultos con respecto a la introducción de innovaciones.

(e) Expansión de los Servicios de Extensión.- Para ser efectivo, un servicio de extensión debe cubrir al máximo posible todas las áreas agrícolas de un país. Es frecuente el caso de servicios de extensión que confinan el número de sus oficinas rurales a las áreas más importantes o de mayor adelanto agrícola. Se entiende que el trabajo de extensión es más fácil de realizar en los lugares más avanzados, donde los agricultores están más acostumbrados a utilizar los adelantos de la ciencia y son consiguientemente más receptivos. Este proceder puede acentuar la diferencia, que es ya bastante notoria en muchos de los países en desarrollo, entre las áreas más favorecidas y aquellas más apartadas o de menores recursos. Es hacia estos últimos lugares que debe dirigirse un mayor esfuerzo como contribución al establecimiento de un balance apropiado entre la población de un país, si se acepta el trabajo de extensión como un factor de progreso que puede también operar con efectividad en los lugares menos favorecidos. El crecimiento de un servicio de extensión debe ser gradual y especialmente en concordancia con la disponibilidad del personal capacitado, pero el programa nacional debe contemplar desde su elaboración el establecimiento de servicios de extensión en todas las áreas agrícolas del país. Si la aplicación apropiada y amplia de los descubrimientos de la ciencia y la tecnología agrícolas se reconoce necesaria para el desarrollo de los países cuya economía depende principalmente de la agricultura, lo cual es el caso más frecuente en los países menos avanzados, los servicios de extensión agrícola pueden considerarse como la piedra fundamental para el desarrollo de la mayoría de los países del mundo.

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**SUMMARY**

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Food and Agriculture Organization

# THE ROLE OF AGRICULTURAL EXTENSION IN THE APPLICATION OF SCIENCE AND TECHNOLOGY

By Enrique A. SUMMERS,
Chief, Agricultural Education
and Extension Branch,
Rural Institutions and Services Division,
F.A.O.

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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# THE ROLE OF AGRICULTURAL EXTENSION IN THE APPLICATION OF SCIENCE AND TECHNOLOGY

by

Enrique A. Summers, Chief
Agricultural Education and Extension Branch
Rural Institutions and Services Division
F A O

1. Task of the Extension Services - The dissemination of information derived from agricultural science and technology is the primary purpose of extension work. Extension is an informal educational process directed to teach farmers to improve their production and raise their standard of living; the agricultural extension services are the organisms designed to perform this task. The fundamental objectives of extension are to promote and facilitate individual and group action towards greater and faster progress in the rural areas.

2. Dynamic Nature of Extension - Extension is a factor of agricultural and rural progress which uses the results of research to achieve its purposes. As a process which is complementary to research, extension must be dynamic. Extension endeavours to change the static situation which prevail in the rural areas into a dynamic one. The degree to which the extension service is able to do this is determined by the quality of its personnel, its working facilities, its relations with the sources of knowledge and the degree of cooperation it maintains with other rural services.

3. Extension is an Essential Complement to Research -

a) This concept is well understood and practiced in the agriculturally advanced countries. In the developing countries, normally a number of improved practices have been developed by research. However the application of these findings is very limited due to the fact that this information does not reach the mass of the agricultural population. The development of improved methods is not the final

purpose of applied research, the final objective must be the widespread application by farmers. Extension services are responsible for this ample dissemination of available information

b) Extension services take care of trials necessary to determine the local applicability of new discoveries.

c) Problems of the rural areas are brought to the attention of research stations by the extension services, thus developing a two way process which contributes to directly research work towards the present and most pressing problems of farmers.

d) As complementary activities, research and extension must participate mutually in the planning of their respective programs of work.

4. Utilization of Research Results from Other Countries - This is an important source of information for extension services. A large part of all agricultural improvement is of universal application or require slight modifications to be applied to local conditions. This calls for a close collaboration between research and extension and the establishment of combined programs of applied research and extension.

5. Accesibility of Available Information - From the education point of view, two important aspects of accesibility of information include:

a) The Accesibility of Information Sources : The small farmers are not in a position to maintain close contact with the experiment stations and institutions of a formal character. They require sources of information closer and better adapted to their environment, an opportunity which is offered to them by extension services.

b) The Way in Which the Available Information is Presented: Information coming from research centres is usually understandable to technicians and well educated persons. Written information is always useful if presented in the terms understood by the farmers and dealing with practical subject of interest to them. However, there are many areas with a majority of illiterate farmers where teaching can only be done by using objective teaching methods. The method most commonly used by

extension workers is the demonstration, in other words, teaching by doing and by showing results. Extension simplifies the information taking into consideration that their audience consists normally of small farmers with a minimum of education.

c) Extension, besides disseminating knowledge, assists the farmer in its application and promotes greater effort for progress. The application of agricultural science and technology can be effective only when the discoveries are accessible to the majority of farmers, to the aim sufficiently staffed and equipped extension services are required.

6. Desirability of Establishing a Unified Extension Service of a General Character - Normally, research institutes are not in a position to perform effective extension work. However, such institutes have a tendency to attempt themselves to disseminate their findings. This dissemination is inadequate both in coverage and intensity, and the presence of several specialized technicians working independently in one location gives way to controversial recommendations. Extension considers agricultural enterprises as a unit giving attention to all technical, economical and social problems, establishing adequate priorities in the development of the enterprise. The immediate and continued observation of the rural environment places the extension service in a position to determine the specific action required for speeding up progress. However, extension requires back-stopping by specialists to solve specific problems. Due to the special nature of extension work and to the scarcity of personnel and of financial resources, particularly in the developing countries, a unified extension service of a general character is the most advisable approach to effective extension work.

7. Factors which determine the Effectiveness of Extension Services:

a) Training of Personnel: This is the most important factor. To remedy the scarcity of trained personnel regional and national extension centers have been organized, and it is estimated that the latter should be intensified. The following measures may contribute to the training of extension personnel:

(i) National agricultural extension training centers.

(ii) Periodical refresher courses on technical subject matter.

(iii) Introduction of courses in the social sciences and extension education in the programs of study of faculties and schools of agriculture.

(iv) Cooperation of faculties and schools of agriculture and extension services in providing in-service training to groups of students during the vacation periods.

b) Equipment and Supplies for Extension Offices - Extension workers should have adequate transportation facilities, equipment and materials necessary to cover properly their area and to conduct the demonstrations and other activities essential for performing their work effectively. The absence of these elements are deficiencies frequently found in the developing countries, resulting in semi-active and ineffective extension services.

c) Assistance of Specialists: A body of specialists should be attached to the extension services or specialized assistance should come from the research centers by establishing an adequate system of cooperation between both institutions.

d) Establishment or Reinforcement of Rural Youth Programs: These programs are a useful complement to formal education. Experience in many countries shows that rural youth is most receptive to extension work and that rural youth work contributes strongly to changing attitudes of adults.

e) Expansion of Extension Services: Extension work should not be confined to the most important or better developed agricultural areas. Sufficient attention should be given to isolate and less favored areas, a policy which will contribute to a balanced development of the rural population. Extension services should expand gradually and national extension programs should consider covering all the agricultural areas of a country. If the proper and widespread application of agricultural science and technology is recognized as necessary for the economic development of countries depending mainly on agriculture, as is the case in less developed countries, then extension services can be considered as fundamental for the development of the majority of countries of the world.

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